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[PROOF] Need

[TITLE OF DOCUMENT] Specification

[TITLE OF THE INVENTION] Method for manufacturing solid-state imaging device.

[SCOPE OF CLAIMS]

[CLAIM 1] A method for manufacturing solid-state imaging device, wherein a transparent substrate, in which a number of spacers surrounding around said solid-state imaging elements are formed, is adhered by an adhesive onto a wafer whereon a number of solid-state imaging elements are formed, and said transparent substrate and said wafer are divided based on said solid-state imaging device for each,

characterized in that after adhering a transfer plate coated with said adhesive is adhered onto said spacers of said transparent substrate and pressing said transfer plate and said transparent substrate, said transfer plate is stripped off from said transparent substrate so as to form by transforming a layer of said adhesive on said spacer.

[CLAIM 2] A method for manufacturing solid-state imaging device claimed in claim 1, characterized in that said transfer plate is a rigid body.

[CLAIM 3] A method for manufacturing solid-state imaging device claimed in claim 2, characterized in that said transfer plate applies a glass plate as a rigid body.

[CLAIM 4] A method for manufacturing solid-state imaging device claimed in claim 1, characterized in that said transfer plate is an elastic body.

[CLAIM 5] A method for manufacturing solid-state imaging device claimed in claim 4, characterized in that said transfer plate applies a flexible plastic film as an elastic body.

[CLAIM 6] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 5, characterized in that a ridge pattern or a recess pattern, which is the same shape as said spacers formed on said transparent substrate, is formed on said transfer plate.

[CLAIM 7] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 6, characterized in that a release agent is coated on the surface of said transfer plate.

[CLAIM 8] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 7, characterized in that said release agent is silicon.

[CLAIM 9] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 8, characterized in executing a surface modification process to the surface of said spacer to be coated with said adhesive.

[CLAIM 10] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 9, characterized in that a viscosity of said adhesive is more than 100cps.

[CLAIM 11] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 10, characterized in that said transfer plate is coated with said adhesive by applying bar coat, blade coat, or spin coat.

[CLAIM 12] A method for manufacturing solid-state imaging device claimed in one of claim 1 or 11, characterized in that

said transfer plate and said transparent substrate is pressed by air pressure or roller pressure.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF INVENTION]

The present invention relates to a method for manufacturing solid-state imaging device applying a wafer level chip size package structure.

[0002]

[PRIOR ARTS]

Digital cameras, wherein a solid-state imaging device and a semiconductor memory are used instead of silver salt film, are commonly used. Small electronic equipment such as a mobile phone and an electronic databook, wherein the solid-state imaging device and the semiconductor memory are mounted so as to enable photographing, are also widely used. In a conventional solid-state imaging device, a solid-state imaging element chip, wherein solid-state imaging elements such as CCD or the like are provided on a wafer, is bonded to a package formed of ceramic or the like, and after electrically connecting the solid-state imaging element chip and a terminal of the package by using a bonding wire, a glass lid formed of transparent glass is attached to the package so as to seal the solid-state imaging element chip.

[0003]

In order to downsize the digital cameras and small electronic equipment, it is desired to downsize the solid-state

imaging device. As one of implementation methods for downsizing the solid-state imaging device, there is a wafer level chip size package method (hereinafter CSP) completing implementation of the solid-state imaging device at a wafer level without using the package (see Reference 1 as an example). In this solid-state imaging device using the wafer level CSP, spacers are arranged with surrounding around the solid-state imaging device onto the upper surface of the solid-state imaging element chip, a cover glass is attached on the spacers so as to seal the solid-state imaging element, and connecting terminals are formed on the upper surface, side surfaces, and a lower surface of the solid-state imaging element chip.

[0004]

In the solid-state imaging device using the wafer level CSP is manufactured by forming a number of spacers on a transparent glass substrate, which is a base material for a cover glass, coating ends of each spacer with adhesive, and after adhering together the glass substrate and a wafer wherein a number of solid-state imaging element are formed, dicing the glass substrate and the wafer.

[0005]

In the solid-state imaging device of the wafer lever CSP structure, it is necessary to adhere the spacer and the wafer together not to protrude and to appropriately seal between them. This is to prevent a yield from being damaged by cooling water entering into the spacer as dicing.

[0006]

[Reference 1] Japan Patent Laid-open Publication Number 2002-231921

[0007]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

In order to appropriately adhere the spacer and the wafer, the thickness of the adhesive coated on the spacer needs to be thin and even. However, by the method of adhering by means of potting by dropping a small amount of the adhesive having high viscosity as cited in the Reference 1, it is impossible to coat the adhesive to the spacer having a width of less than 200 μm. Even if the spacer has the width of more than 200μm, it takes too much time to execute potting to each side of a number of spacers on the glass substrate.

[0008]

Though it is cited in the Reference 1 to coat the adhesive on the spacer by printing, it may be hardly realized, as it is hard to align printing positions to each spacers and to control the thickness of the coating. Furthermore, silicon used as the material of the spacer tends to repel the adhesive, and that makes very difficult to coat the adhesive with even thickness onto the spacers having minute dimensions.

[0009]

The present invention is to solve the above problem and aims at coating the adhesive with appropriate thickness onto the spacer.

[0010]

[MEANS FOR SOLVING THE PROBLEMS]

In order to the above problems, a manufacturing solid-state imaging device of the present invention is after adhering a transfer plate coated with coating adhesive onto a transparent substrate spacer and pressing the transfer plate and the transparent spacer, stripping off the transfer plate from the transparent substrate to transfer-form a adhesive layer. Thereby, the adhesive may be coated thinly and evenly onto the spacer, and that enables to adhere the spacer and a wafer without protruding adhesive and with appropriately sealing between the spacer and the wafer.

[0011]

As the transfer plate, a rigid body such as glass and flexible plastic film and the like may be used, and they may be selected according to the number of the spacer and the type of the adhesive. Additionally, by forming a ridge pattern or a recess pattern, the same form as the spacer, on the transfer plate, the adhesive coated onto the pattern may be transferred to the spacer.

[0012]

Furthermore, it is possible to coat a release agent onto the transfer plate and to coat the adhesive onto the release agent. That eases the adhesive to be stripped off from the transfer pate, and since the adhesive coated on the transfer plate may be transferred to the spacer directly, the coating thickness on the transfer plate may be alternatively controlled instead of controlling of the coating thickness on the spacer.

[0013]

Additionally, it is possible to executing a surface

modification process to the surface of the spacer to be coated with said adhesive. Thereby, the coating property of the adhesive is improved so as to coat more evenly. Furthermore, a viscosity of the adhesive is preferably more than 100cps, in order to control the coating thickness easily. In addition, the transfer plate may be coated with the adhesive evenly by applying bar coat, blade coat, or spin coat. Moreover, the transfer plate and the transparent substrate may be adhered to each other evenly by being pressed with air pressure or roller pressure.

[0014]

[EMBODIEMENTS OF THE INVENTION]

Fig.1 and Fig.2 respectively show a perspective view of an apparent form and a main part partial cross view of a solid-state imaging device of the wafer level CPS structure manufactured by the manufacturing method of the present invention. The solid-state imaging device 2 is composed of a solid-state imaging element 3, a rectangular-shaped solid-state imaging element chip 5, on which a plural of connecting terminal 4 are provided to connect electrically to the solid-state imaging element 3, a frame-shaped spacer 6 attached onto the chip 5 to surround the solid-state imaging element 3, and a cover glass 7 attached on the spacer 6 to seal the sold-state imaging element 3. The width of the spacer 6 is 200μm, for example, and the height is 10-500μm, or80-120μm more preferably.

[0015]

The solid-state imaging element 3 is composed of CCD, for

example. A color filter and a micro lens are laid on the CCD. The connecting terminal 4 is formed by printing on the solid-state imaging element chip 5 with using, for example, a conductive material. Similarly, the connecting terminal 4 and the solid-state imaging element 3 are wired together by printing. The solid-state imaging element chip 5 is formed by dicing each solid-state imaging element after a number of solid-state imaging elements 3 and connecting terminals 4 are formed on the wafer. The spacer 6 is formed of an inorganic material, such as silicon, for example. As the cover glass 7, an α beam shielding glass is used so as to prevent photo diode of the CCD from being destructed.

[0016]

Fig.3 is a flow chart showing a manufacturing process of the above solid-state imaging device. In the first step, as shown in Fig.4, a number of the spacers 6 are formed on the glass substrate 10, which is a substrate of the cover glass 7. Those spacers 6 are formed by the following method: for example, first, laying the inorganic material such as silicon and the like by coating by spin coat and the like or by a CVD device so as to form an inorganic material membrane. Next, forming a number of spacers 6 out of the inorganic material membrane by means of a photolithography technique, development, etching, and the like. Alternatively, adhering the glass substrate 10 and the silicon wafer together so as to form the inorganic material membrane on the glass substrate 10. Furthermore, the spacer may also be formed directly by printing the inorganic material onto

the glass substrate 10.

[0017]

As shown in Fig.5, an adhesive 12 is coated to the end faces of the spacers 6 on the glass substrate 10 thinly and evenly in the second step. As the adhesive 12 to use adhere the spacer 6 and the wafer, for example, epoxy resins, silicon resins, and the like are used to prevent from deformation as hardening and from entering of water to gain high reliability. Additionally, the adhesive having viscosity of 100-10000cps is used to improve the controlling of the coating thickness of the adhesive 12. Note that UV hardened adhesive, visible light hardened adhesive, and heat hardened adhesive may be used if they provide the same effect.

[0018]

The coating of the adhesive to the spacer 6 is executed by from the second-1 to the second-4 steps shown in from Fig.6 to Fig.8. In the second-1 step, a transfer film 16 is put on a work table 15, which is made of glass to have high planarity, as shown in Fig.7(A). The transfer film 16, used as a transfer plate, is held on the work table 15 by being sucked by means of air suction not to shift or to generate wrinkles.

[0019]

The transfer film 16 is a thin film formed to be flat by means of polyethylene terephthalate (PET) and has an exterior size larger than that of the glass substrate 10. Onto the transfer film 16 put on the work table 15, the adhesive 12 is coated by means of a coat bar 17 of a bar coater with thickness

of 6-10 μm, or 8 μm more preferably. Note that a blade coater and a spin coater may be used for coating the adhesive 12 to the transfer film 16.

[0020]

It is generally known that an optical room-temperature hardened adhesive has a bad coating property to the inorganic material such as silicon, which is used as a material of the spacer 6, and that the coating property is improved by enhancing the viscosity. Using adhesive having high viscosity, however, makes it difficult to control the coating thickness. In the present embodiment, accordingly, a time-based process is executed in the second-2 step by coating the adhesive 12 to the transfer film 16 and leaving it for a predetermined time so as to enhance the viscosity of the adhesive 12. In this time-based process, it is needed to adjust the temperature and the time such that the viscosity of the adhesive 12 becomes about 9500-10000cps. Thereby, since the viscosity of the adhesive 12 is changed by the time-based process, it is possible to control the coating thickness precisely by using the adhesive 12 having low viscosity as coating to the transfer film 16.

[0021]

Note that, if using the hydrophilic adhesive, the spacer 6 may be executed surface modification by emitting plasma or ultraviolet rays to the spacer 6. Thus, the coating property of the adhesive to the silicon spacer may be improved.

[0022]

In the second-3 step, the glass substrate 10 and the transfer

film 16 are adhered to each other by alignment equipment or by hand. For example, as shown in Fig.7(B), the alignment equipment is composed of a glass holder table 20 for holding by sucking the glass substrate 10 by means of the air suction from a suction holes 20a, and a film holder table 21, which is disposed below the glass holder table 20, executes air suction from the suction holes 21a to hold the transfer film 16 via a sponge 21b by sucking. The film holder table 21 is movable into up and down direction in the same manner as a well-known Z-axis moving table.

[0023]

The film holder table 21 moves upward while the transfer film 16 coated with the adhesive 12 is put on the sponge 21b, so as to press evenly the transfer film 16 to a number of spacers 6 on the glass substrate 10. The sponge 21b to be used has hardness capable of pressing the transfer film 16 firmly to the spacers 6 without breaking the spacers 6. Thus, the adhesive 12 on the transfer film 16 and the spacers 6 are certain to contact to each other, and the glass substrate 10 and the transfer film 16 are adhered to each other. Note that the glass substrate 10 and the transfer film 16 may be adhered to each other by shifting a pressure roller on the glass substrate 10.

[0024]

In the second-4 step, the transfer film 16 is stripped off from the glass substrate 10, and the adhesive 12 is transferred onto the spacers 6. As shown in Fig.8, the film peeling equipment used in this step is composed of a work table to hold the glass substrate 10 put on the work table by sucking by means of air

suction and the like, a winding roller 22 to engage one end of the transfer film 16, and a peeling guide 24 to keep the angle θ between the transfer film 16 and the glass substrate 10 constant when they are being peeled, with abutting the upper surface of the transfer film 16. The work table 22 is slidable horizontally in the figure by, for example, a table shifting mechanism used for a XY table.

[0025]

In the film peeling equipment, the winding roller 23 is started to wind the transfer film 16 simultaneously with the work table 2 slides into the left side in the figure, so as to peel the transfer film 16 sequentially from one end of the glass substrate 10. In this time, since the rear surface of the transfer film 16 is limited by the peeling guide 24, the angle θ between the transfer film 16 and the glass substrate 10, and the adhesive 12 is transferred in a certain thickness onto each spacer 6 on the glass substrate 10. Note that, if the size of the transfer film 16 is not large to be able to engage with the winding roller 23, an extension film may be attached to one end of the transfer film 16.

[0026]

In the third step, as shown in Fig.9(A), the glass substrate 10 is adhered onto a wafer 26, on which a number of solid-state imaging elements 3 and connecting terminals 4 are formed. Note that the glass substrate 10 and the wafer 26 have the same size and the same shape, as shown in Fig.10. An alignment bonding equipment is used to adhere the glass substrate 10 and the wafer

26. The alignment bonding equipment comprises a bonding table 28 to hold and position the wafer 26 by sucking air from air suction holes 28a and a positioning table 29 to hold the glass substrate 10 by sucking air from suction holes 29a to adjust the position of the XY direction and rotating direction of the glass substrate 10 according to the wafer 26.

[0027]

The positioning table 29 adjusts the positions of the wafer 26 and the glass substrate 10 by using orientation flat lines 26a and 10a of the wafer 26 and the glass substrate 10, and alignment marks provided appropriately. Then, the positioning table 29 moves downward to overlap the glass substrate 10 on the wafer 26 and presses evenly the entire glass substrate 10 with relatively weak pressure. Thereby, the glass substrate 10 and the wafer 26 are temporarily adhered. Note that the reason of that the sponge used in the alignment equipment in Fig.7(B) is not used in the alignment bonding equipment for adhering the glass substrate 10 and the wafer 26 is that, in adhering the glass substrate 10 and the wafer 26, highly precise positioning adjustment is required between the solid-state imaging elements 3 and the spacers 6.

[0028]

The glass substrate 10 and the wafer 26 temporarily attached each other by the alignment bonding equipment is adhered firmly by a pressure bonding equipment shown in Fig.9(B) not to peeled off from each other. The pressure bonding equipment comprises a bonding table 30 for positioning and holding the glass

substrate 10 and the wafer 26 by means of air suction from air suction holes 30a, and a pressure table 33 positioned over the bonding table 30 for pressing evenly the glass substrate 10 via a sponge 33a. The pressure by the pressure bonding equipment to the glass substrate 10 and the wafer 26 is continued for a predetermined time until the adhesive 12 is hardened.

[0029]

In the fourth step, dicing of the glass substrate 10 is executed to form a number of cover glasses 7 out of the glass substrate 10, as shown in Fig.11. When dicing the glass substrate 10, cooling water is poured from an injection nozzle 32 toward a diamond cutter 31 and the glass substrate 10 to prevent them from heated too much. Since between the spacer 6 and the wafer 26 are certainly leased by the adhesive 12, the cooling water cannot enter the spacer 6 as dicing of the glass substrate 10.

[0030]

In the fifth step, a dicing tape 34 is attached to the lower surface of the wafer 26, as shown in Fig.12. Then, the wafer 26 is diced by the diamond cutter 35 to form a number of the solid-state imaging device 2. Though the cooling water is poured from the injection nozzle 36 as dicing the wafer 26, the cooling water cannot enter the spacer 6 as well.

[0031]

Note that a silicon-coated film may be used as the transfer film, if the adhesive used to adhere the spacer 6 and the wafer 26 may also be coated on a releasing film such as the

silicon-coated film and the like and, simultaneously, has better coating property to the spacer 6 than to the silicon-coated film. Thereby, since peeling property of the adhesive from the transfer film improves significantly, all of the adhesive 39, in the adhesive 39 coated on the transfer film 38 as shown in Fig.13 (A), upper from the part connecting with the spacer 6 is transferred to the spacer 6, as shown in Fig.13 (B). Thus, since the coating thickness of the adhesive 39 coated on the transfer film 38 becomes the same thickness of the adhesive 39 transferred to the spacers 6, the amount of the adhesive 39 to be transferred to the spacers 6 may be easily controlled by controlling the coating thickness of the adhesive 39 to the transfer film 38.

[0032]

Note that, in the above embodiment, though the flexible plastic film is used as the transfer plate, a rigid body having high planarity such as glass may also be used as the transfer plate. When using the rigid body as the transfer plate, it is needed to strip off slowly the transfer plate from the glass substrate so as to certainly transfer the adhesive to the spacer. Alternatively, a ridge pattern or a recess pattern having the same shape as the spacer may be formed on the transfer plate. It may contact the transfer plate and the spacer more certainly when using the ridge pattern, and when using the recess pattern, the amount of the adhesive to be transferred may be adjusted according to the depth of the recess pattern. Alternatively, by forming pits at the ends of the spacers to be adhered to the

wafer, surplus of the adhesive may be gathered into the pit not to protrude from the spacers.

[0033]

As explained above, according to the method for manufacturing solid-state imaging device of the present invention, since it is possible to coat the adhesive on the spacers evenly with appropriate thickness, the spacer and the wafer may be adhered to each other such that between the spacer and the wafer is appropriately sealed without protruding the adhesive.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Figure 1]

An external perspective view illustrating a composition of a solid-state imaging device manufactured by using the present invention.

[Figure 2]

A cross-sectional view of a main part illustrating a composition of the solid-state imaging device.

[Figure 3]

A flow chart showing a manufacturing procedure of the solid-state imaging device.

[Figure 4]

A cross-sectional view of a main part illustrating a glass substrate to which a number of spacers are formed in the first step.

[Figure 5]

A cross-sectional view of a main part illustrating an

adhesive is coated on the spacers of the glass substrate in the second step.

[Figure 6]

A flow chart showing operating procedure in the second step.

[Figure 7]

An explanatory view illustrating a transfer method of the adhesive to the spacer in the second-1 step.

[Figure 8]

An explanatory view illustrating a method for stripping off the transfer film from the spacer in the second-1 step.

[Figure 9]

A cross-sectional view of a main part illustrating a condition wherein the glass substrate and the wafer are adhered together in the third step.

[Figure 10]

A perspective view illustrating external shapes of the glass substrate and the wafer.

[Figure 11]

A cross-sectional view of a main part illustrating dicing of the glass substrate in the fourth step.

[Figure 12]

A cross-sectional view of a main part illustrating dicing of the wafer in the fifth step.

[Figure 13]

An explanatory view illustrating a condition of transferring the adhesive by the second embodiment of the present invention.

[DESCRIPTION OF THE REFERENCE NUMBERS]

2 solid-state imaging device

3 solid-state imaging element

4 connecting terminal

5 solid-state imaging element chip

6 spacer

7 cover glass

10 glass substrate

12 adhesive

16 transfer film

23 winding roller

24 peeling guide

26 wafer

[TITLE OF DOCUMENT] Abstract

[ABSTRACT]

[OBJECT] Coating adhesive on a spacer evenly with appropriate thickness.

[RESOLUTION] A spacer 6 of a substrate 10 and a transfer film 16 coated with an adhesive 12 are adhered to each other. The glass substrate 10 is put on a work table 22, a peeling guide 24 is placed on top of the transfer film 16, and one end of the transfer film 16 is engaged with a winding roller 23. Then, the work table 22 is slide into the left side in the figure, and, simultaneously, the transfer film 16 is wound by the winding roller 23. In this time, since the rear surface of the transfer film 16 is limited by the peeling guide 24, the angle θ between the glass substrate 10 and the transfer film 16 is kept constant, and a certain thickness of the adhesive 12 is transferred to each spacer 6 of the glass substrate 10.

[ELECTED FIGURE] Figure 8